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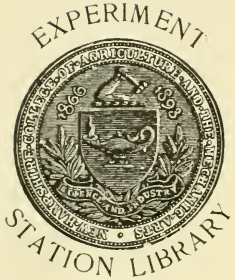

Class 639.73

Number N53

Volume 3 cop 2

Source Binding

Received July 1909

Cost

Accession No. 15435

Bulletin 123 February, 1906

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

Inspection of Fertilizers

IN 1905

IN COÖPERATION WITH THE

STATE BOARD OF AGRICULTURE

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM

TRADE VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS, 1905.

	Cents per pound
Nitrogen in ammonia salts	17.5
Nitrogen in nitrates	17.
Nitrogen in dry and fine ground fish, meat and blood, and in high grade mixed fertilizers	18.5
Nitrogen in fine ground bone and tankage	18.
Nitrogen in coarse bone and tankage	13.
Phosphoric acid soluble in water	4.5
Phosphoric acid soluble in ammonia citrate (reverted)	4.
Phosphoric acid in fine ground bone, fish and tankage	4.
Phosphoric acid in coarse bone and tankage	3.
Phosphoric acid in cottonseed meal, castor-pomace and wood ashes	4.
Phosphoric acid insoluble in mixed fertilizers	2.
Potash as sulphate free from chlorides and in wood ashes	5.
Potash as muriate	4.25

The above values are based on the wholesale market price for the materials, when sold in large lots at the principal trade centers in New England. The valuation of a ton of any mixed fertilizer based on the above figures will usually fall ten dollars below the retail price at the local agency. This variation includes such fixed charges as cost of mixing, bags, cartage and freight, salaries and commissions of agents and interest.

Nitrogen in all forms of organic matter and in nitrate of soda, was advanced one cent a pound, while in ammonia salts it remained at the price adopted in 1904.

THE INSPECTION OF FERTILIZERS IN 1905.

The fertilizer inspection was conducted as usual by the coöperation of the State Board of Agriculture and the New Hampshire College Agricultural Experiment Station. The chemist of the latter institution executed the necessary chemical work assisted by Edward H. Goodnow, William O. Robinson and Edwin J. Roberts.

One hundred and five different brands of mixed fertilizers were sampled and analyzed during the inspection.

There were twenty-seven cases of failure to equal the guarantee in one or more ingredients, but in all but nine of them, a lack in one element was made good by an excess of another, without affecting the value of the goods.

The majority of deficits was found in available phosphoric acid in the lower grades of goods.

The numerous brands can be practically all arranged in twenty-five groups or classes, a table of which is shown on an accompanying page. The groups are arranged principally in the order of their nitrogen and potash contents, since there is always an abundance of phosphoric acid present and it varies between narrower limits.

It is important to note that forty per cent. of the brands contained less than two per cent. of nitrogen, and that few of these contained any marked amount of inorganic nitrogen. In practically all the higher grades a good portion of the nitrogen is present in the inorganic form, which means that usually nitrate of soda or sometimes sulphate of ammonia, is present, and a quickly acting fertilizer is insured.

As a rule, there is a larger proportion of soluble phosphoric acid than of the reverted form, which indicates a carefully prepared superphosphate. Although soluble phosphoric acid soon reverts in the soil, it is reasonable to assume that it is more evenly distributed by reverting in the soil water after the application than when reverted in the fertilizer before it is used.

CLASSIFICATION OF FERTILIZERS BY COMPOSITION.

Class.	Per cent. total nitrogen.	Per cent. available phosphoric acid.	Per cent. soluble potash.	Number of brands in class.
A.	....	10–11	2	5
B. 1	.82	7–8	1	5
B. 2	.82	7–9	2	4
B. 3	.82	7–8	3	3
B. 4	.82	8	4	4
B. 5	.82	6	8	1
C.	1.00	8	2	3
D. 1	1.20	6.5–8.5	3	3
D. 2	1.23	7–9	2	4
E. 1	1.64	8	2.5	4
E. 2	1.64	8–9	3	3
E. 3	1.64	7–8	4	3
E. 4	1.64	6	6	1
F. 1	2.00	8.5	2	10
F. 2	2.00	8–9	3	12
G. 1	2.5	9	2	4
G. 2	2.5	9	4	3
G. 3	2.5	7–9	5	4
G. 4	2.5	8–9	6	3
G. 5	2.5	6	10	4
H. 1	3.3	8–10	7	7
H. 2	3.3	6–9	10	4
I.	3.7	8	9–10	2
J.	4.1	7	6–8	3
K.	5	5	6.5	2

MANUFACTURER AND BRAND.	Nitrogen.				Phosphoric Acid.							Potash.	
			Total.				Available.			Total.			
	Inorganic.	Organic.	Found.	Guaranteed.	Soluble.	Reverted.	Found.	Guaranteed.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.
AMERICAN AGRICULTURAL CHEMICAL CO.													
Bradley's Corn Phosphate	.58	1.62	2.20	2.06	3.63	5.03	8 66	8.0	2.84	11.50	10.0	2 21	1.5
Bradley's Complete Manure for Corn and Grain	1.42	1.90	3.32	3.30	5.10	5.18	10.28	12.0	1.89	12.17	13.0	6 12	3.0
Bradley's Complete Manure for Potatoes and Vegetab's	.60	2.70	3.30	3.29	4.96	2.99	7.95	8.0	1.70	9.65	9.0	7.40	7.0
Bradley's Complete Manure for Top Dressing	4.96	.25	5.21	4 95	1.45	3.98	5.43	5.0	1.95	7.38	6.0	3.30	2.5
Bradley's Complete Manure with 10 per cent. Potash	1.24	1.89	3.13	3.29	3.90	5.48	9.38	6.0	1.70	11.08	7.0	10.08	10.0
Bradley's Eclipse Phosphate	.33	1.13	1.46	1.03	4.20	3.59	7.79	8.0	2.39	10.18	10.0	2.02	2.0
Bradley's Potato Manure	.70	1.87	2.57	2.50	4.93	2.15	7.08	6.0	2.20	9.28	8.0	5.46	5.0
Bradley's Potato Fertilizer	.50	1.69	2.19	2.06	6.31	3.38	9.69	8.0	3.06	12.75	10.0	3.11	3.0
Bradley's XL Superphosphate	.68	1.79	2.47	2.50	4.08	5.06	9.14	9.0	2.60	11.74	11.0	2.70	2.0
Clark's Cove Bay State Fertilizer G. G	.79	1.60	2.39	2.06	4.25	4.74	8.99	8.0	1.71	10.70	10.0	2.51	1.5
Clark's Cove Potato Fertilizer	.34	2.18	2.52	2.06	5.67	2.56	8.23	8.0	2.42	10.65	10.0	3.20	3.0
Cleveland Fertilizer for All Crops	.....	1.17	1.17	1.03	5.81	2.19	8 00	8.0	2.41	10.41	10.0	3.24	2.0
Cleveland Potato Phosphate	.41	1.90	2.31	2.06	5.00	3.21	8.21	8.0	2.47	10.68	10.0	3 20	3 0
Cleveland Superphosphate	.82	1.36	2.18	2.06	5.22	3.07	8.29	8.0	2.26	10.55	10.0	2.01	1.5
Crocker's Ammoniated Corn Phosphate	.46	1.47	1.93	2.06	5.31	3.29	8.60	8.0	2.12	10.72	10.0	1.84	1.5
Crocker's Grass and Oats Fertilizer	.....	.....	.....	.....	6.36	4.35	10.71	11.0	2.27	12.98	12.0	2.11	2.0
Crocker's New Rival Ammoniated Superphosphate	.....	1.15	1.15	1.03	3.62	4.16	7.78	8.0	2.33	10.11	10.0	2.30	2.0
Crocker's Potato, Hop and Tobacco Fertilizer	.44	1.70	2.14	2.06	6.00	3.26	9.26	8.0	1.93	11.19	10.0	3.00	3.0
Crocker's Special Potato Manure	1.23	2.09	3.32	3.30	4.48	2.27	6.75	6.0	1.05	7.80	7.0	10.05	10.0
Cumberland Guano	.31	1.08	1.39	1.03	4.55	3.00	7.55	8.0	2.40	9.95	10.0	2.39	2.0
Cumberland Potato Fertilizer	.71	1.43	2.14	2.06	5.68	2.71	8.39	8.0	2.53	10.92	10.0	3.28	3.0
Cumberland Superphosphate	.80	1.37	2.17	2.06	5.59	2.81	8.40	8.0	2.08	10.48	10.0	1.88	1.5
Darling's Blood, Bone and Potash	1.00	2.75	3.75	4.10	3.76	3.72	7.48	7.0	2.09	9.57	8.0	7.03	7.0
Darling's Farm Favorite	.65	1.62	2.27	2.06	5.00	3.01	8.01	8.0	2.54	10.55	9.0	3.38	3.0
Darling's General Fertilizer	.27	1.05	1.32	1.20	4 47	2.13	6.60	6.0	2.50	9.10	7.0	6.02	3.0

COMPOSITION OF COMMERCIAL FERTILIZERS SAMPLED AND ANALYZED IN 1905.—*Continued.*

MANUFACTURER AND BRAND.	Nitrogen.				Phosphoric Acid.							Potash.	
			Total.				Available.			Total.			
	Inorganic.	Organic.	Found.	Guaranteed.	Soluble.	Reverted.	Found.	Guaranteed.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.
Darling's Potato Manure	.77	1.95	2.72	2.50	4.65	2.20	6.85	6.0	2.44	9.29	8.0	5.83	5.0
Fine Ground Bone	.....	.....	2.48	2.47	.....	.....	9.76	.....	15 93	25.69	22.0	.....	.....
Great Eastern Garden Special	1.52	1.80	3.32	3.30	5.19	3.66	8.85	8.0	2.18	11.03	9.0	6.18	7.0
Great Eastern Potato Manure	.63	1.42	2.05	2.06	5.81	2.88	8.69	8.0	2.19	10.88	10.0	3.18	3.0
Great Eastern Northern Corn Special	.50	1.51	2.01	2.06	5.06	3.81	8.87	8.0	2.25	11.12	10.0	1. 0	1.5
Great Eastern General Fertilizer	.....	1.40	1.40	.82	6.52	2.30	8.82	8.0	1.77	10.59	10.0	3.74	4.0
High Grade Fertilizer with 10 per cent. Potash	.74	1.59	2.33	2.47	4.29	1.56	5.85	6.0	2.92	8.77	7.0	10.59	10.0
Packer's Union Animal Corn Fertilizer	.81	1.78	2.59	2.5	5.61	4.10	9.71	9.0	1.90	11.61	11.0	2.35	2.0
Packer's Union Gardener's Complete Manure	.76	1.78	2.54	2.4	3.75	2.00	5.75	6.0	1.69	7.45	7.0	10.04	10.0
Packer's Union Potato Manure	.79	1.62	2.41	2.06	5.53	3.51	9 04	8.0	2.33	11.37	10.0	5.76	6.0
Packer's Union Universal Fertilizer	.....	.96	.96	.82	4.99	3.63	8.62	8.0	1.77	10.39	10.0	4.02	4.0
Packer's Union Wheat, Oats and Clover Fertilizer	.....	.....	.....	.....	5.93	4.75	10.68	11.0	2.09	12.77	12.0	2.43	2.0
Pacific Potato Special	.55	1.68	2.23	2.06	4.99	3.25	8.24	8.0	2.94	11.18	10.0	3.22	3.0
Plain Superphosphate	.....	.....	.....	.....	8.80	4.45	13.25	14.0	1.90	15.15	15.0	.....	.....
Quinnipiac Corn Manure	.58	1.78	2.36	2.06	3.90	4.74	8.64	8.0	2.44	11.08	10.0	2.05	1.5
Quinnipiac Dissolved Bone and Potash	.....	.....	.....	.....	6.69	4.49	11.18	10.0	2.23	13.41	11.0	2.04	2.0
Quinnipiac Potato Phosphate	.49	1.72	2.21	2.06	4.72	3.22	7.94	8.0	1.95	9 89	10.0	3.09	3.0
Read's Farmers' Friend Superphosphate	.46	1.71	2.17	2.06	5.44	3.83	9 27	8.0	2.17	11.44	10.0	3.13	3.0
Read's Potato Manure	.79	1.71	2.50	2 46	3 40	2.50	5.90	6.0	2.09	7.99	7.0	11.22	10.0
Reads Practical Potato Special	.....	.87	.87	82	4.41	2.00	6.41	4.0	2.54	8.95	5.0	9.57	8.0
Read's Vegetable and Vine Fertilizer	.81	1.57	2.38	2.06	5.68	3.33	9.01	8.0	2.09	11.10	10.0	6.02	6.0
Read's Standard Superphosphate	.....	.96	.96	.82	6.35	2.00	8.35	8.0	1.94	10.29	10.0	4.01	4.0
Soluble Pacific Guano	.59	1.84	2.43	2 06	4.09	3.59	7.68	8.0	2.62	10.30	10.0	2.01	1.5
Williams & Clark's Americus Am. Bone Superphosphate	.73	1.63	2.36	2.50	6.32	2.72	9.04	9.0	1.91	10.95	11.0	2.13	2.0
Williams & Clark's Americus Potato Manure	.55	1.59	2.14	2.06	5.37	3.68	9.05	8.0	2.48	11.53	10.0	3.43	3.0

Williams & Clark's Prolific Crop Producer	.....	.98	.98	.82	3.20	2.94	6.14	7.0	2.68	8.82	8.0	1.50	1.0
Bowker Fertilizer Co.													
Bowker's Corn Phosphate	.24	1.68	1.92	1.65	5.29	3.04	8.33	8.0	1.52	9.85	9.0	2.15	2.0
Bowker's Farm and Garden Phosphate	.36	1.36	1.72	1.65	3.40	5.29	8.69	8.0	2.94	11.63	9.0	2.11	2.0
Bowker's Early Potato Manure	.89	2.74	3.63	3.30	4.36	3.11	7.47	7.0	2.03	9.50	8.0	7.02	7.0
Bowker's Hill and Drill Phosphate	.86	1.72	2.58	2.47	5.91	3.49	9.40	9.0	2.90	12.30	10.0	2.45	2.0
Bowker's Lawn and Garden Dressing	2.42	.62	3.04	3.0	3.76	2.99	6.75	4.0	1.18	7.93	8.0	5.63	5.0
Bowker's Potash or Staple Phosphate	.....	.79	.79	.82	3.95	4.19	8.14	8.0	1.59	9.73	9.0	3.09	3.0
Bowker's Potato and Vegetable Fertilizer	.60	1.92	2.52	2.47	6.75	1.94	8.69	8.0	2.50	11.19	9.0	3.90	4.0
Bowker's Potato and Vegetable Phosphate	.29	1.66	1.95	1.65	4.99	2.89	7.88	9.0	2.14	10.02	10.0	2.17	2.0
Bowker's Sure Crop Bone Phosphate	.34	.62	.96	.82	5.45	2.93	8.38	9.0	1.57	9.95	10.0	2.31	2.0
Stockbridge Corn Manure	.94	2.41	3.35	3.30	5.40	4.62	10.02	10.0	2.43	12.45	11.0	6.98	7.0
Stockbridge Potato and Vegetable Manure	.84	2.33	3.17	3.30	3.66	2.92	6.58	6.0	2.03	8.61	7.0	9.38	10.0
Stockbridge Top-Dressing Manure	1.36	3.47	4.83	4.94	2.02	2.97	4.99	4.0	2.61	7.60	6.0	6.36	6.0
Stockbridge Seeding-Down Manure	1.00	1.41	2.41	2.47	3.82	1.99	5.81	6.0	2.24	8.05	9.0	10.25	10.0
E. Frank Coe Co.													
Coe's Celebrated Special Potato Fertilizer	.....	1.96	1.96	1.66	7.30	.85	8.15	8.0	1.43	9.58	10.0	4.28	4.0
Coe's Columbian Corn Fertilizer	.....	1.65	1.65	1.20	7.68	2.21	9.89	8.5	1.76	11.65	10.0	3.09	2.5
Coe's Columbian Potato Fertilizer	.....	1.90	1.90	1.20	4.98	2.63	7.61	8.5	3.84	11.45	10.5	3.65	2.5
Coe's Famous Grass and Grain Fertilizer	.....	1.27	1.27	.80	6.22	3.62	9.84	8.5	.78	10.62	10.0	2.55	1.5
Coe's High Grade Ammoniated Bone Superphosphate	.....	2.13	2.13	1.85	7.88	1.25	9.13	9.0	2.25	11.38	11.0	2.26	2.25
Coe's High Grade Dissolved Bone and Potash	.....	.....	.....	.....	5.30	5.60	10.90	10.5	3.98	14.88	12.5	2.45	2.0
Coe's New England Corn Phosphate	.....	1.46	1.46	.80	6.13	1.48	7.61	7.5	2.72	10.33	9.0	3.07	3.0
Coe's New England Potato Fertilizer	.....	1.58	1.58	.80	6.18	2.24	8.42	7.5	2.06	10.48	9.0	3.24	3.0
Coe's XXV Ammoniated Bone Phosphate	.....	1.19	1.19	.80	8.26	.83	9.09	8.5	2.09	11.18	10.0	2.13	1.6
Lister's Agricultural Chemical Co.													
Lister's Animal Bone and Potash	.....	.....	.....	.....	5.47	4.67	10.14	11.0	2.36	12.50	12.0	2.39	2.0
Lister's Oneida Special Fertilizer	.29	.97	1.26	.82	3.94	2.57	6.51	7.0	2.43	8.94	9.0	2.13	1.0
Lister's Potato Manure	1.10	2.13	3.23	3.30	5.78	2.60	8.38	8.0	1.49	9.87	9.0	6.54	7.0
Lister's Special Corn Fertilizer	.....	1.94	1.94	1.65	6.60	2.87	9.47	8.0	2.26	11.73	9.0	3.22	3.0
Lister's Special Potato Fertilizer	.....	1.94	1.94	1.65	7.03	2.62	9.65	8.0	2.27	11.92	9.0	3.13	3.0
Lister's Success Fertilizer	.....	1.68	1.68	1.24	7.28	2.63	9.91	9.0	1.95	11.86	11.0	2.00	2.0

COMPOSITION OF COMMERCIAL FERTILIZERS SAMPLED AND ANALYZED IN 1905.—*Concluded.*

MANUFACTURER AND BRAND.	Nitrogen.				Phosphoric Acid							Potash.	
			Total.				Available.			Total.			
	Inorganic.	Organic.	Found.	Guaranteed.	Soluble.	Reverted.	Found.	Guaranteed.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.
LOWELL FERTILIZER CO.													
Swift's Lowell Animal Brand	.18	2.28	2.46	2.46	6.70	3.17	9.87	9.0	1.61	11.48	10.0	4.34	4.0
Swift's Lowell Bone Fertilizer	.....	1.63	1.63	1.64	6.12	2.03	8.15	8.0	1.55	9.70	9.0	3.20	3.0
Swift's Lowell Cereal Brand	.....	.75	.75	.82	5.07	1.28	6.35	7.0	.90	7.25	8.0	1.01	1.0
Dollar Brand Phosphate	.....	1.21	1.21	.83	6.00	2.24	8.24	8.0	1.15	9.39	.....	1.70	1.0
Swift's Lowell Empress Brand	.....	1.40	1.40	1.23	5.48	1.66	7.14	7.0	1.09	8.23	8.0	2.09	2.0
Swift's Lowell Potato Manure	.....	1.58	1.58	1.64	5.48	2.21	7.69	7.0	1.49	9.18	8.0	4.32	4.0
Swift's Lowell Potato Phosphate	.28	2.12	2.40	2.46	6.04	2.25	8.29	8.0	1.91	10.20	9.0	6.17	6.0
Swift's Lowell Special Grass Mixture	.81	3.13	3.94	4.11	5.26	2.19	7.45	7.0	1.48	8.93	8.0	6.56	6.0
Swift's Lowell Superior Fertilizer	1.00	2.78	3.78	3.71	5.77	2.28	8.05	7.0	1.25	9.30	8.0	10.21	10.0
NEW ENGLAND FERTILIZER CO.													
New England Corn and Grain Fertilizer	.....	1.16	1.16	1.33	5.39	2.29	7.68	7.0	1.42	9.10	8.0	2.37	2.0
New England Potato Fertilizer	.....	1.56	1.56	1.64	5.33	1.55	6.88	7.0	1.49	8.37	8.0	4.46	4.0
OHIO FARMERS' FERTILIZER CO.													
Ammoniated Bone and Potash	.....	.57	.57	.82	5.17	2.79	7.96	8.0	1.38	9.34	10.0	3.55	4.6
General Crop Fish Guano	.15	1.28	1.43	.82	4.19	4.25	8.44	7.0	2.76	11.20	9.0	1.12	1.0
PARMENTER & POLSEY FERTILIZER CO.													
A. A. Brand	.70	3.33	4.03	4.10	5.04	2.68	7.72	7.0	1.54	9.26	8.0	8.76	8.0
"P. & P." Grain Grower Brand	.....	.78	.78	.82	4.61	1.35	5.96	7.0	1.32	7.28	8.0	2.53	2.0

"P. & P." Potato Fertilizer	.....	1.71	1.71	1.64	4.18	1.87	6.05	6.0	1.20	7.25	7.0	5.42	6.0
Plymouth Rock Fertilizer	.16	2.16	2.32	2.47	5.85	3.13	8.98	8.0	1.70	10.68	9.0	4.04	4.0
Special Potato Fertilizer	.28	2.60	2.88	3.29	5.27	3.52	8.79	8.0	2.51	11.30	9.0	7.00	7.0
Star Brand Superphosphate	.....	1.76	1.76	1.64	4.78	2.57	7.35	7.0	2.48	9.83	8.0	2.76	2.5
RUSSIA CEMENT CO.													
Essex A1 Superphosphate	.....	1.23	1.23	1.0	2.81	4.58	7.39	7.0	5.16	12.55	9.0	2.07	2.0
Essex Complete Manure for Corn, Grain and Grass	.82	2.32	3.14	3.3	6.69	2.63	9.32	7.0	1.60	10.92	9.5	10.36	9.5
Essex Complete Manure for Potatoes, Roots and Veg's.	.87	2.85	3.72	3.70	4.25	3 00	7.25	7.0	5.72	12.97	9.0	9.46	8.5
Essex Corn Fertilizer	.60	1.61	2.21	2.00	3.23	6.06	9.29	9.0	3.44	12.73	11.0	3.09	3.0
Essex Market Garden and Potato Manure	.50	1.97	2.47	2.00	4.48	5.28	9.76	8.0	2.09	11.85	10.0	5.68	5.0
Essex XXX Fish and Potash	.91	1.52	2.43	2.10	3.03	5.40	8.43	9.0	3.95	12.38	12.0	2.51	2.25
J. W. SANBORN.													
Sanborn's Chemical Fertilizer for Grass and Oats	2.24	2.80	5.04	5.20	2.70	3.27	5.97	3.5	2.18	8.15	7.1	6.82	6.5
Sanborn's Chemical Fertilizer for Hill and Drill	1.54	1.06	2.60	2.80	4.10	8.21	12 31	7.0	2.60	14.91	13.0	3.02	3.0
Sanborn's Chemical Fertilizer for Potatoes	2.18	1.61	3.79	3.80	4.49	4.18	8.67	7.7	1.98	10.65	9.8	7.97	7.2

FRED W. MORSE, *Chemist.*

THE USE OF COMMERCIAL FERTILIZERS.

BY FRED W. MORSE.

It should always be borne in mind that the success of a crop depends on four other conditions besides that of the fertilizer used to feed it. All farm crops require certain average amounts of heat, light, air and water in order to develop an average growth, and just the right amount of each for the largest possible yield.

Thus weather conditions may favor or hinder a crop to such an extent that the fertilizer has apparently no effect, and these facts have led more than one to the conclusion that fertilizers were useless. On the contrary, since plants must have from some source the elements found in fertilizers, it follows that they should be of value, and a careful study of fertilizer experiments shows that fertilizers, whether commercial or in barnyard manure, cause a smaller variation in yield between good and bad seasons, by increasing the yields in bad seasons while holding their own in exceptionally good seasons.

Fertilizers cannot make good a lack of sunshine or rain, but they can help the sunshine and rain to do their best; therefore when the weather is favorable they increase the profits and when it is unfavorable they lessen the losses.

The condition of the soil in its relation to air and water is of the greatest importance in the profitable use of commercial fertilizers. When a soil is too wet, it allows too little air to reach the roots of plants, simply because the water crowds it out. In average seasons some soils are too wet and others are too dry for the following reasons: A crop of three tons of hay, or one of fifteen tons of silage corn per acre, would result in the removal from the soil of about eight hundred tons of water. To supply this water there would need to be between seven inches and eight inches of rainfall during the growing season of each crop. At Durham, the average rainfall in

April, May and June is $9\frac{1}{2}$ inches, and during May, June, July and August it is $12\frac{8}{10}$ inches. If this rain were uniformly distributed, it would be fully enough for grass and a little too much for corn. As it is not, both crops need the soil in such condition that it will hold enough water at all times for their needs, while allowing the surplus to drain away.

On soils of average texture the requisite moisture conditions can be maintained by tillage, and if needed, by drainage on low levels; but with extreme types, as heavy clay loams, or light sandy loams, there is needed more thorough treatment by increasing the amount of vegetable matter, since there is no more effective way of making over a soil in its relation to water and air than this.

In using commercial fertilizers as a source of the food elements needed by crops, it should be remembered that there is little positive evidence that they can make over the soil in its relation to water, hence they always do their best work and are most profitable on soils which are in good average condition, neither too heavy and wet nor too light and dry. Furthermore, the continuous growth of annual crops, whether hoed or broadcast, adds no vegetable matter to the soil, except in the roots and stubble, and it is common to find that the first crop of corn on sod land, with commercial fertilizers, is superior to that of the second year, undoubtedly because the vegetable matter of the old turf helped maintain a satisfactory moisture condition in the first year and was largely destroyed before the second year.

The most economical use of commercial fertilizers is only reached when they are applied in rotations in which the soil is maintained in good moisture condition by the use of barnyard manure or the vegetable matter from crops grown for the purpose.

Although the food elements in a commercial fertilizer form but one of the several conditions needed for the best development of the crop, it is important that these elements should be suited to the demands of the crop at every stage of its growth, else the product will not be as large as the other conditions would permit. It is the most common practice to use this

class of fertilizers with the annual crops, and there are good reasons for such practice as shown by fertilizer experiments.

Annual crops, whether oats, corn, potatoes or vegetables, require that their food elements shall be ready to hand as their growth makes new demands. The commercial fertilizer, then, should be able to furnish available food elements throughout the growing season, and in the proper proportion required by the crop.

A study of the chemistry of plant growth shows very clearly that there must be present a continuous supply of available nitrogen, which requires that some shall be in the inorganic and some in organic form.

The more quickly the crop is to be grown in the spring, the more inorganic nitrogen will be needed, since it is sooner ready for the plants than organic forms. Soluble phosphoric acid produces results more quickly and thoroughly than the other forms, and a well-made fertilizer should have at least half of its available phosphoric acid in the soluble form. All crops remove from the soil much more potash than phosphoric acid, and although the soil may furnish some of it, without the positive evidence of field experiments to that effect, a fertilizer should have at least as much potash as it has soluble phosphoric acid.

Commercial fertilizers may be advantageously used in top-dressing grass, and for such a purpose it should have a high percentage of nitrogen, of which nearly all should be inorganic. The phosphoric acid should be nearly all soluble in order to be of marked benefit, and the fertilizer should be applied in early spring while the soil is thoroughly moist.

Finally, in the purchase of fertilizers it should be borne in mind that it costs just as much to mix, bag, freight and handle a ton of low grade fertilizer as one of high grade. By purchasing a half ton of the highest grade goods one buys more and better nitrogen, as much potash and enough phosphoric acid to balance them, for less money than he would pay for a ton of low grade goods, because he saves half the cost of the above different items.

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N. H. Exp. Sta.
Buls. 97-129
1903-1907.

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